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ATTRACTICIDE RESISTANCE MONITORING TECHNIQUE FOR ASSAYING INSECTICIDE RESISTANCE IN PINK BOLLWORM, *PECTINOPHORA GOSSYPIELLA* (SAUNDERS) FIELD POPULATIONS

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Abstract

Attracticide resistance monitoring technique was used for measuring insecticide resistance in pink bollworm (PBW) male moths, *Pectinophora gossypiella* (Saunders). This technique eliminates handling of insects and is compatible with the current practice of monitoring populations with pheromone traps. Results showed that, PBW developed resistance to all insecticides tested with RR of 19 and 12.7 folds in early and late season 1996 for fenvalerate, 12.8 and 47.2 folds for chlorpyrifos, 14.1 and 34.7 folds for delfose, 14.1 and 38.5 folds for empire and 22.6 and 56 folds for thiodicarb, respectively.

This technique was used to estimate discriminating concentration (DC) (LC_{90} of a field strain in 1996 early season) for the tested insecticides. The highest level of resistance ratio was 97.44 fold against thiodicarb in late 1997, while the lowest one was 13.18 fold against fenvalerate in late 1997.

Key words: Insecticide, resistance, monitoring, attracticide, discriminating concentration.

INTRODUCTION

Resistance to insecticides is one of the most serious problems facing agriculture. The problem is often noticed by a loss of effectiveness of an insecticide in controlling a pest population (Haynes *et al.* 1986). There is an immediate need for simple and effective methods to monitor insecticide resistance to help preserve the increasingly rare resource of effective chemicals for pest population control (Haynes *et al.* 1987).

The attracticide resistance monitoring technique was created and perfected by Riedl *et al.* (1985) for resistance monitoring in codling moth, *Cydia pomonella*, using delta sticky traps baited with pheromone source, these traps were used to collect the adult and then it was assayed by topical application. While (Haynes *et al.* 1986) mentioned the 1st use of yellow sticky cards incorporating with various dosages of selected insecticides in pheromone traps to monitor insecticide resistance in field populations in many insects. This method employs delta traps baited with pheromone that are ordinarily used for assessment of populations of male moth pink bollworm (Miller 1990).

Knight *et al.* (1990) used sex pheromone traps coated with concentrations of azinophosmethyl impregnated adhesive to test levels of resistance in adult populations of male tufted apple bud moth from apple orchards in seven Eastern States .The results suggest that the level of resistance found within an orchard may be influenced by the intensity of fruit production within a region.

Miller (1990) determined the toxicity of carbamate, organophosphorus and pyrethroid insecticides by the attracticide method to field populations of pink bollworm in cotton growing areas of Texas, Arizona, California, Mexico and China.

Al-Beltagy *et al.* (1996) used pheromone delta sticky traps as an attracticide tolerance monitoring technique in two different locations having two different control strategies for the pink bollworm. Pheromone traps as an attracticide tolerance monitoring technique proved to be effective, simple and quick for assaying the moth field strains of lepidoptera for insecticide resistance.

MATERIALS & METHODS

1. INSECT PESTS USED

Pink bollworm (PBW) : *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae)

a. Field male moth population of PBW: A field culture of PBW was collected locally from cotton fields in Kafr El-Dawar District, El-Bouheira Governorate, Egypt, through 1995-1998 using a modified pheromone baited live traps. These traps were distributed around the cotton fields by a rate of one trap/ 5 feddans and were fixed higher than the foliage by 20-30 cm. All the traps were installed before sunset and collected quickly in the following morning before sunrise (dawn) and transferred directly to the laboratory to obtain live moths.

b. Susceptible strain of PBW: The susceptible colony of PBW was supplied by the Bollworm Research Department, Plant Protection Research Institute, Agricultural Research Center, Dokki, Giza, Egypt, where it has been reared for several years in conditioned laboratory without exposure to insecticides. The rearing procedure was adopted as that recorded by Abdel- Hafez *et al.* (1982) .

2. INSECTICIDES USED

a. Pyrethroid (Fenvalerate): EC 20%, Application rate: 600 ml/fedden.

b. Organophosphorus: (Chlorpyrifos): EC 48%, Application rate: 1 liter/ fedden.

c-Mixtures:

- **Delfos** Mixture of Chlorpyrifos (48%) + Hexaflumuron (2%).
  : EC 50%, Application rate: 1 liter/fedden.
- **Empire** Mixture of Chlorpyrifos 48% + Diflubenzuron 3%
  : FL 51%, Application rate: 1 liter/fedden.

d. Carbamate: Thiodicarb :WG 80%, Application rate : 0.5 kg/fedden

3. Procedure of Attracticide Resistance Monitoring Technique (ARMT)

A novel resistance monitoring method was created and perfected for pink bollworm by Miller (1986) and Haynes *et al.* (1986 and 1987).

This method employs delta traps baited with pheromone that are usually used for assessment of populations of male moths as following steps:

1. 3.5 gm of mixture of sticky adhesive and insecticides were scraped on insert cards using a putty knife starting with the lowest concentration and ending to the highest one, every time the putty knife was washed with kerosene and dried.

2. The traps were hung on stakes higher 20 - 30 cm above the canopy of cotton plant and distributed by a rate of one trap\ Five cotton feddans.

3. The dosed insert cards and control undosed cards were placed into the delta traps with a pheromone source, randomly. All cards were inserted before sunset.

4. Traps were left overnight and quickly in the following morning all the insert cards were collected at dawn with the trapped adult male moths and checked for mortality %, this termed the zero time mortality %, then placed each insert card into the holding container. The cards were collected at dawn to avoid the heat of the day, the trapped moths will not be well if they were allowed to warm up in the morning sun.

5. The cards were kept away of the sun in the shadow until they were delivered from the field to their storage site.

6. It is very important to store the insert cards in the holding containers in a constant temperature 25 ± 3°C for 24 hours. After 12 hr. and 24 hr. cards were removed from the container and mortality were recorded. The adult was scored as alive if any movement was recorded (i.e., leg, abdomen, wing, even the antenna). The insects were recorded as died if they did not move at all.

7. Each dose and control were replicated three or more times.

8. When all doses and cards have been accounted for and all insects have been checked for mortality, these data together with the mortality of controls for each insecticide were analyzed.

4. STATISTICAL ANALYSIS

a. Regression equation and confidence limits: Regression equation and confidence limits were calculated according to (Finney 1971) probit analysis computer program.

b. Toxicity Index (T.I.): was calculated for each insecticide according to Sun (1950) as follow:

$$\text{Toxicity Index (T.I.)} = \frac{LC_{50} \text{ of the most toxic insecticide}}{LC_{50} \text{ of the tested insecticide}} \times 100$$

c. Relative Toxicity (R.T.): These values were measured according to the equation of Metcalf (1967) as follow:

$$\text{Relative Toxicity Index (R.T.)} = \frac{LC_{50} \text{ of the lowest toxic insecticide}}{LC_{50} \text{ of the tested insecticide}} \text{ (Fold)}$$

d. Resistance Ratio (R.R.): Resistance ratio values were calculated according to the following equation:

$$\text{R.R.} = \frac{LC_{50} \text{ of the field strain}}{LC_{50} \text{ of the susceptible strain}} \text{ (Fold)}$$

e. Developed Resistance Ratio (DRR): These values were calculated according to (Shekeban 2000)

$$\text{DRR} = \frac{\text{calculated mortality \% of the discriminating concentration}}{\text{observed mortality \%}} \times \text{R.R.}$$

RESULTS AND DISCUSSION

Assaying PBW male moths resistance levels to different insecticides

a. Susceptibility of susceptible strain at 24 hr. assessment: Data at 24 hr. assessment, Table 1 indicate that, fenvalerate was the most toxic insecticide against susceptible strain (LC_{50} = 2.1 ppm), while empire was the lowest toxic one (LC_{50} = 9.3 ppm). Whereas the LC_{50} value of thiodicarb was (5.9 ppm), delfos was (8.1 ppm) and chlorpyrifos was (8.9 ppm).

b. Susceptibility of field strain at zero time assessment: Results from zero time assessment, Table 2 in early season 1995 show LC_{50} values of fenvalerate, chlorpyrifos, delfos, empire and thiodicarb equal to : 196.8, 793.2, 864.9, 939.7 and 1099.3 ppm, respectively, while the corresponding LC_{50} values in late season, Table 3 were : 142.2, 1430.1, 1255.9, 1312.3 and 1472.1 ppm, respectively.

c. Susceptibility of field strain at 12 hr. assessment: Data from 12 hr. assessment in early 1996, Table 4 indicate that, the LC_{50} values of the above mentioned insecticides were: 61.8, 257.9, 280.4, 391.9 and 346.7 ppm, respectively, while the LC_{50} values in late 1996, Table 5 were: 49.5, 872.1, 693.7, 730.6 and 780.7 ppm, respectively.

d. Susceptibility of field strain at 24 hr. assessment: Data show the LC_{50} values of fenvalerate, chlorpyrifos, delfos, empire and thiodicarb at 24 hr. assessment, Table 6 equal to : 40.0, 113.4, 114.2, 131.2 and 133.3 ppm, respectively, whereas the LC_{50} values in late 1996, Table 7 were: 26.9, 420.1, 280.8, 356.2 and 330.2 ppm, respectively.

The previous data indicate that, the resistance ratios to fenvalerate, chlorpyrifos, delfos, empire and thiodicarb in early season 1996, Table 8 were: 19, 12.7,14.1,14.1 and 22.6 fold, respectively, while these values in late season 1996, Table 9 were: 12.8,47.2,34.7,38.3 and 56.0 fold, respectively. These data show that, the resistance ratios increased from early to late season except for fenvalerate, where it decreased and pointed out to an increase in the LC_{50} values of fenvalerate, chlorpyrifos, delfos, empire and thiodicarb against PBW male moths, field strain, compared to susceptible strain. Also, fenvalerate appeared to be the most toxic insecticide compared with other used ones, this shows the importance of pyrethroids used in controlling bollworm moths. As the duration time increase, the LC_{50} values become low and the 24 hr. assessment is the best duration to calculate LC_{50} values for moths.

a. Discriminating Concentration and Developed Resistance Ratios in PBW Male Moths: Results drived out the application of DC (LC_{90}) show the DRR values against fenvalerate insecticide equal to: 13.82, 13.18 and 13.82 fold for early 1997, late 1997 and late 1998, respectively. While the DRR values against chlorpyrifos at the same periods were: 62.3, 70.8 and 62.3 fold, respectively. The DRR values of the same periods against delfos were 44.76, 52.05 and 48.93 fold, respectively. Whereas these values at the same periods against empire were 51.32, 57.45 and 40.98 fold, respectively. The DRR values at these periods against thiodicarb, were 79.52, 97.44 and 60.48 fold, respectively.

Reviewing the above mentioned results, it could concluded that DRR values were increased from season to another, but they came back in late season 1998. This is because the widely use of pheromone disruption technique and the lowest dependence on insecticides in PBW control program .

This finding is in agreement with the finding of Plapp *et al.* (1990) that detected high level of resistance in the first tobacco budworms collected in the spring, while late in the spring and early in summer, the percentage of resistance declines sharply , reaching a level low enough to allow for effective midseason control of tobacco budworms by pyrethroids . Osman *et al.* (1991) found the field strain of PBW reverted to resistance level close to the susceptible laboratory strain within five generations after insecticide pressure was removed. In this respect, Campanhola *et al.* (1991) showed that, if resistance is associated with biological constraints, the resistance gene(s) would decline in frequency when selection pressure is removed. Therefore, by removing selection pressure for one or more generations and using alternate insecticide or other control strategies, the frequency of a resistance gene can be decreased to a level where control is once again possible.

Table 1. Toxicity of different insecticides against PBW male moths, susceptible strain, at 24 hr. using ARMT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y=-0.64+1.99 X	2.1 (2.74 – 1.57)	14.1 (20.5 – 10.1)	4.43	100
II. Chlorpyrifos (O.P.)	Y=- 1.96+2.07 X	8.9 (10.9-7.2)	55.1 (77.8 – 39.5)	1.04	23.6
III-a Delfos (Mixture)	Y= -1.59+1.75 X	8.1 (10.5-6.3)	70.6 (108.6 – 46.8)	1.15	25.9
III-b Empire (Mixture)	Y= -1.98+2.05 X	9.3 (11.4- 7.5)	59 (83.7-42.1)	1	22.6
IV. Thiodicarb (Carbamate)	Y= -1.51+ 1.97 X	5.9 (7.4-4.6)	40.3 (58 – 28.4)	1.58	35.6

Table 2. Toxicity of different insecticides against PBW male moths, field strain at zero time in early season 1995, using ARMT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y=-6.94+3.02X	196.8 (217.8 – 177.8)	688.6 (836.8- 567.1)	5.59	100
II. Chlorpyrifos (O.P.)	Y=- 7.88+2.72X	793.2 (884.4-711.4)	3195.8 (4007.4 – 2549.8)	1.39	24.8
III-a Delfos (Mixture)	Y= -6.34+2.15X	864.9 (983.7-760.5)	5053.7 (7057.5 – 3622.3)	1.27	22.8
III-b Empire (Mixture)	Y= -6.33+2.13X	939.7 (1066.1- 827.5)	5564.9 (7894.7-3926.7)	1.17	20.9
IV. Thiodicarb (Carbamate)	Y= -6.36+ 2.09 X	1099.3 (1246.7-969.3)	6711.1 (9894.2- 4556.7)	1.00	17.9

Table 3. Toxicity of different insecticides against PBW male moths, field strain, at zero time in late season of 1995 using ARMT .

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -5.84+2.71 X	142.2 (160.3-126.1)	575 (699.8-472.8)	10.35	100
II. Chlorpyrifos (O.P.)	Y= -7.68+2.43 X	1430.1 (1604.8- 1274.6)	6775 (9671.3- 4749.9)	1.03	9.9
III-a Delfos (Mixture)	Y= -7.48+ 2.41 X	1255.9 (1400.7- 1126)	6031.9 (8329.7- 4371.3)	1.17	11.3
III-b Empire (Mixture)	Y= -7.51+ 2.41 X	1312 .3 (1464.7- 1175.8)	6311. 5 (8761.1- 4550.3)	1.12	10.8
IV. Thiodicarb (Carbamate)	Y= -7.72 + 2.44 X	1472.1 (1639.2 – 1322.2)	6962.8 (9703.7 – 49999.6)	1.00	9.7

Table 4. Toxicity of different insecticides against PBW male moths, field strain, at 12 hr. in early season of 1996, using ARMT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -2.35+ 1.31 X	61.8 (74.4- 51.4)	1111.2 (2118.8 – 589.5)	6.34	100
II. Chlorpyrifos (O.P.)	Y= -3.79+ 1.57 X	257.9 (304.3- 218.6)	2876.1 (4711.8- 1763.2)	1.52	24
III-a Delfos (Mixture)	Y=-3.70 + 1.57 X	280.4 (333 – 236.1)	3438.2 (5856 – 2028.3)	1.40	22
III-b Empire (Mixture)	Y=-3.27 + 1.26 X	391.9 (487.5 – 315.3)	7937.8 (17597.5 –3611.2)	1.00	15.8
IV. Thiodicarb (Carbamate)	Y= -2.84 + 1.12 X	346.7 (448.5- 268.5)	10320.4 (28466.5 – 3792.3)	1.13	17.8

Table 5. Toxicity of different insecticides against PBW male moths, field strain, at 12 hr. in late season of 1996 using ARMT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -2.36 + 1.39 X	49.5 (59.1 – 41.5)	750.6 (1302.4 – 436.6)	17.62	100
II. Chlorpyrifos (O.P.)	Y= -3.14 + 1.07X	872.1 (1282.7 – 595.2)	30436 (108476 – 8680.2)	1.00	5.7
III-a Delfos (Mixture)	Y= -2.74 + 0.97 X	693.2 (99.1 – 482.7)	35042.7 (141363.6 – 8856.2)	1.26	7.1
III-b Empire (Mixture)	Y= -3.67 + 1.28 X	730.6 (909.6 – 587.6)	14001.3 (30599 – 6449)	1.19	6.8
IV. Thiodicarb (Carbamate)	Y= -2.79 + 0.96 X	780.5 (1099.3 – 555.8)	39776.2 (158581.8 – 1.149.7)	1.12	6.3

Table 6. Toxicity of different insecticides against PBW male moths, field strain at 24 hr. in early season of 1996, using ARMT.

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -2.65+ 1.65 X	40 (46.9 – 34.1)	395.2 (587.4 – 267.5)	3.33	100
II. Chlorpyrifos (O.P.)	Y= -3.68 + 1.79X	113.4 (135.9 – 94.5)	940.7 (1330.7 – 666.9)	1.18	35.3
III-a Delfos (Mixture)	Y= -2.86 +1.39 X	114.2 (144.4 – 90.2)	1736.7 (2887.2 – 1050.1)	1.17	35
III-b Empire (Mixture)	Y= -4.14 + 1.96 X	131.2 (154.1 – 111.7)	959.7 (1242.4 – 667.6)	1.02	30.5
IV. Thiodicarb (Carbamate)	Y= -3.59 + 1.69X	133.3 (157.7 – 112.7)	1252.6 (1867.2 – 843.3)	1.00	30

Table 7. Toxicity of different insecticides against PBW male moths, field strain at 24 hr. in late season of 1996, using ARMT .

Insecticides	Regression Equation Y= a+ bx	LC_{50} (ppm) [Confidence Limits]	LC_{95} (ppm) [Confidence Limits]	R.T.	T.I.
I. Fenvalerate (pyrethroid)	Y= -1.96 +1.37 X	26.9 (34.1 -21.7)	424 (713.4 - 254.9)	15.62	100
II. Chlorpyrifos (O.P.)	Y= -3.59 + 1.37 X	420.1 (522.7- 337.9)	6700.5 (14137.9 - 3200.2)	1.00	6.4
III-a Delfos (Mixture)	Y= -3.03 + 1.24 X	280.8 (341.9 - 230.7)	5977.1 (123386 - 2917.9)	1.50	9.6
III-b Empire (Mixture)	Y= -3044 + 1.35 X	356.2 (436.6 - 290.7)	5913.1 (11478.9 - 3068)	1.18	7.6
IV. Thiodicarb (Carbamate)	Y= -3.39 + 1.35 X	330.2 (401.3 - 271.7)	5510.6 (10608.6 - 2879.9)	1.27	8.1

Table 8. LC_{50}'s of different insecticides against PBW male moths, field and susceptible strains at 24 hr. and resistance ratio (RR) values , using ARMT.

Insecticides	LC_{50} susc. strain	LC_{50} field strain [early 1996]	RR	LC_{50} field strain [late 1996]	RR
I. Fenvalerate (pyrethroid)	2.1	40	19	26.9	12.8
II. Chlorpyrifos (O.P.)	8.9	113.4	12.7	420.1	47.2
III-a Delfos (Mixture)	8.1	114.2	14.1	280.8	34.7
III-b Empire (Mixture)	9.3	131.2	14.1	356.2	38.3
IV. Thiodicarb (Carbamate)	5.9	133.3	22.6	330.2	56

Table 9. Observed mortality % (M%) of different insecticides against PBW male moths, field strain and the developed resistance ratio values (D.R.R.), using ARMT.

Insecticides	Calculated LC_{90} (ppm)	M% Early 1997	D.R.R. Early 1997	M% Late 1997	D.R.R. Late 1997	M% Late 1998	D.R.R. Late 1998
I. Fenvalerate (pyrethroid)	220	83	13.82	87	13.18	83	13.82
II. Chlorpyrifos (O.P.)	580	68.3	62.3	60	70.8	68.3	62.3
III-a Delfos (Mixture)	875	69.9	44.76	60	52.05	63.7	48.93
III-b Empire (Mixture)	600	67.3	51.32	60	57.45	84	40.98
IV. Thiodicarb (Carbamate)	760	63.5	79.52	51.7	97.44	83.4	60.48

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استكشاف المقاومة باستخدام مصائد الجاذبات الجنسية القاتلة للتعرف على المقاومة للمبيدات في العشائر الحقلية لدودة اللوز القرنفلية

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تقييم مستوى مقاومة ذكور دودة اللوز القرنفلية للمبيدات المختلفة:

تشير النتائج بعد ٢٤ ساعة من التعرض أن الفنفاليرات هو أكثر المبيدات سمية ضد ذكور السلالة الحساسة (ت ق ٥٠ = ٢,١ جزء فى المليون) بينما كان الامبير هو الأقل سميه (ت ق ٥٠ = ٩,٣ جزء فى المليون). كما أشارت النتائج بعد رفع الكروت اللاصقة مباشرة (وقت الصفر) فى أول الموسم وأخره أن الفنفاليرات هو أكثر المركبات سمية ضد ذكور السلالة الحقلية(ت ق ٥٠ = ١٩٦,٨ و١٤٢,٢جزء فى المليون على التوالى) بينما كان الثيوديكارب هو أقلهم سميه (ت ق ٥٠ = ١٠٩٩,٣و١٤٧٢,١ جزء فى المليون على التوالى). أوضحت نتائج التقييم بعد ١٢ ساعة من رفع الكروت اللاصقة فى أول وأخر موسم ١٩٩٦ أن الفنفاليرات هو أكثر المركبات سميه ضد السلالة الحقلية بينما جاء ترتيب باقى المركبات فى أول الموسم كالتالى: الكلوربيرفوس ،الديلفوس ،الثيوديكارب وأخيرا الامبير وقد أختلف الترتيب فى أخر الموسم ليصبح كالتالى: الديلفوس ،الأمبير ،الثيوديكارب وأخيرا الكلوربيرفوس. كما أوضحت نتائج التقييم بعد ٢٤ ساعة من رفع الكروت اللاصقة أن الفنفاليرات هو أكثر المركبات سميه سواء فى بداية الموسم أو نهايته بينما كان الثيوديكارب أقلهم سميه فى بداية الموسم فى حين كان الكلوربيرفوس أقلهم سميه فى نهاية الموسم.

أشارت هذه النتائج إلى مستوى مقاومة ضد الفنفاليرات ،الكلوربيرفوس ،الديلفوس ،الامبير ،الثيوديكارب فى أول الموسم كالتالى : ١٩ و١٢,٧ و١٤,١ و١٤,١ ثم ٢٢,٦ ضعف على التوالى بينما كانت تلك القيم فى نهاية الموسم كالتالى: ١٢,٧ و٤٧,٢ و٢٤,٧ و٣٨,٣ ثم ٥٦ ضعف على التوالى.

الجرعة الوصفية وتطور المقاومة :

أوضحت الدراسة التى اجريت باستخدام ت ق ٩٠ كجرعة وصفية ان التطور فى مستوى المقاومة ضد مبيد الفنفاليرات ياخذ القيم ١٣,٨٢ و ١٣,١٨ و١٣,٨٢ ضعف للفترات الزمنية اول موسم ١٩٩٧ واخر موسم ١٩٩٧ واخر موسم ١٩٩٨ على التوالى ، فى حين كانت تلك القيم ولنفس الفترات الزمنية ضد مبيد الكلوربيرفوس كالتالى: ٦٢,٣ و ٧٠,٨ ن ٦٢,٣ ضعف على التوالى . كما اشارت النتائج الى قيم ضد مبيد الديلفوس كالتالى : ٤٤,٧٦ و ٥٢,٠٥ و ٤٨,٩٣ ضعف على التوالى فى حين كانت تلك القيم ضد مبيد الامبير : ٥١,٣٢ و ٥٧,٤٥ و ٤٠,٩٨ ضعف على التوالى واخيرا كانت تلك القيم ضد مبيد الثيوديكارب: ٧٩,٥٢ و٩٧,٤٤ و ٦٠,٤٨ ضعف على التوالى .

توضح النتائج السابقة ان الحشرة تطور مقاومتها ضد المبيدات المختلفة من موسم لاخر فى حين تراجعت قيم المقاومة فى اخر موسم ١٩٩٨ وذلك بسبب الاستخدام المكثف للفرمونات فى المكافحة مع قلة الاعتماد على المبيدات فى برنامج مكافحة دودة اللوز القرنفلية .